"Further Investigations on the Abnormal Outgrowths or Intumescences in *Hibiscus vitifolius*, Linn.: a Study in Experimental Plant Pathology." By ELIZABETH DALE. Communicated by Professor H. MARSHALL WARD, F.R.S. Received November 22, 1900,—Read February 7, 1901.

(Abstract.)

During the summer of 1899 some preliminary experiments were made in order to investigate the conditions determining the formation of certain outgrowths of which the structure had previously been examined.* These outgrowths consist chiefly of greatly enlarged and multiplied epidermal cells, with very thin walls; but the underlying parenchyma is often also affected. The cells concerned always lie immediately around a stoma, so that the guard-cells are lifted up as the outgrowth developes. The distribution of the outgrowths is therefore dependent upon that of the stomata, and they are pathological in origin and nature.

This year (1900) further experiments have been undertaken, which confirm and extend the conclusions suggested by the earlier work, and which show that we have here a clear case of a pathological phenomenon brought under control.

The plants used were chiefly *Hibiscus vitifolius*, but some observations were also made on *Ipomea Woodii*.

The experiments were designed to test the effects of moisture and light in inducing the formation of the intumescences, but they also served to show the influence of temperature. Most of them were made in the open air, as the outgrowths always arise on plants growing in a greenhouse.

I. In order to test the effects of *moisture* in the air and in the soil, plants were kept with their shoots in dry or moist air, and their roots in dry or damp soil. Various combinations of dry or damp air or soil were used, with the result that outgrowths were always formed in damp air (provided there was sufficient light and heat), whereas damp soil had no effect.

II. The effects of *light* were tested by growing plants in white light of varied intensity, and under glass of different colours. Outgrowths were developed under clear and whitewashed glass, and under red and yellow glass, but not under blue or green glass, nor in poor light, and never in darkness.

III. Observations as to the influence of temperature showed that,

* Dale, "On Certain Outgrowths (Intumescences) on the Green Parts of *Hibiscus vitifolius*, Linn.," 'Proc. Camb. Phil. Soc.,' vol. 10, Part 4.

given the other necessary conditions, the formation of outgrowths is promoted by heat.

Large outgrowths may be artifically induced with certainty in about two days on a single healthy branch (still attached to the plant), by isolating it in a damp atmosphere, and exposing it to a strong light at a high temperature.

The following is a brief summary of the principal experiments and conclusions:—

Effects of Moisture.

Number of experiment.	Conditions of experiment.	Result.	Remarks.
1	Shoot in open air; root in moderately damp soil	No outgrowths formed	Growth rapid and plant very healthy.
1*a*	Shoot in air of greenhouse; root in wet, undrained soil	Outgrowths formed	The leaves soon dropped off, and the plant ultimately died, after experiment was stopped.
1*b*	Shoot in open air; root in wet, undrained soil	No outgrowths formed	Leaves dropped off, but the plant recovered when experiment was stopped.
2*a*	Shoot in air of greenhouse; root in damp, undrained soil	Outgrowths formed	
2*b*	Shoot in open air; root in damp, drained soil	No outgrowths formed	Leaves became yellow and curled under.
3*a*	Shoot in air of greenhouse; root in damp, drained soil	Outgrowths formed	
3*b*	Shoot in damp air; root in damp, drained soil	,, ,,	
3*c*	,, ,, ,,	,, ,,	
4	Shoot in damp air: root in dry soil	,, ,,	
5	Shoot in dry air; root in dry soil	No outgrowths formed	Growth retarded.
6	Shoot in very dry air; root in dry soil	,, ,,	,, ,,
7*a*	One shoot (attached to the plant) isolated in damp air	Many outgrowths, on the isolated shoot only	In bright sunlight and hot weather.
7*b*	,, ,, ,,	,, ,,	,, ,, ,,
7*c*	,, ,, ,,	A few outgrowths, on the isolated branch only	In cool, almost sunless weather.
8	One shoot (attached to plant) isolated in water	No outgrowths formed	

Effects of Light.

Number of experiment.	Conditions of experiment.	Result.	Remarks.
9	Poor light; no sun......	No outgrowths formed	
10*a*	Light passing through yellow glass	Outgrowths formed	
10*b*	Light passing through a solution of potassium chromate	,, ,,	
11	Light passing through red glass	,, ,,	
12*a*	Light passing through blue glass	No outgrowths formed	
12*b*	Light passing through a solution of copper sulphate and ammonia	,, ,,	
13	Light passing through green glass	,, ,,	
14	Light passing through whitewashed glass	Outgrowths formed	
15*a*	Plant in darkness in a greenhouse	No outgrowths formed	
15*b*	Plant in darkness under a zinc cylinder in the open	,, ,,	

Effects of Temperature.

The formation of outgrowths (provided there is adequate moisture and light) is promoted by a high temperature.

The conclusions drawn from the above experiments are, that the outgrowths are formed in a moist atmosphere, provided that there is also adequate light and heat.

The immediate effect of the damp atmosphere is to check transpiration. This, in its turn, by blocking the tissues with water, disturbs the normal course of metabolism, and so leads (when the light and heat are sufficient) to changes in the metabolic activity of the plant, as is shown by the following facts :—

1. The outgrowths only develop if transpiration is reduced.
2. The outgrowths are chiefly formed on organs which are actively assimilating, *e.g.*, under ordinary, red or yellow glass; but only if transpiratory activity is lowered: they are not formed in the open.
3. They only occur (*ceteris paribus*) in plants in which there is an accumulation of starch.
4. They are formed under clear glass and under red and yellow glass, but not under blue or green glass, and in no case in darkness.

5. Their formation is accompanied by the production of oil, which is not found in normal leaves.
6. The presence of this oil suggests that events similar to those occurring in succulent plants are taking place, viz., reduced respiration and the development of osmotically active substances in excess.
7. It is therefore probable that the intumescences are due to the local accumulation of osmotically active substances, produced under the abnormal conditions, viz., reduced transpiration and consequent lack of minerals, while carbohydrates are being developed in excess.

"The Integration of the Equations of Propagation of Electric Waves." By A. E. H. LOVE, F.R.S. Received December 29, 1900,—Read February 7, 1901.

(Abstract.)

The equations of propagation of electric waves, through a dielectric medium, involve two vector quantities, which may be taken to be the electric force and the magnetic force; and they express the rate of change, per unit of time, of either vector, in terms of the local values of the other. Various forms may be given to the equations, notably, that employed by Larmor, in which the magnetic force is regarded as a velocity, and the electric force as the corresponding rotation. In this form there is one fundamental vector, viz., the displacement corresponding to the magnetic force, regarded as a velocity; and this displacement-vector may, in turn, be derived from a vector potential. Every one of the vectors in question is circuital; and the several components of them satisfy the partial differential equation of wave propagation, viz., $\ddot{\phi} = c^2\nabla^2\phi$, c being the velocity of radiation.

One way of integrating the equations is to seek *particular* systems of functions of the co-ordinates and the time, which, being substituted for the components of the vectors, satisfy the equations; more general solutions can be deduced by synthesis of such particular solutions. Owing to the circuital relations, certain known solutions of the partial differential equation of wave propagation are not available, for representing the components of the vectors. A very general system of particular solutions, which are available for this purpose, is obtained. These particular solutions are expressed in terms of spherical harmonics and arbitrary functions of the time; and they can be regarded as generalisations of others, given by Lamb, which depend in the same way upon spherical harmonics, and contain simple harmonic functions of the time. By means of them, we can describe two types of sources of electric